

**NATURAL RESOURCES CONSERVATION SERVICE  
CONSERVATION PRACTICE STANDARD**

**LAND RECLAMATION  
SUBSIDENCE TREATMENT**

(ha, acre)  
CODE 454

**DEFINITION**

Treating subsidence areas to reduce the harmful effects and provide for beneficial use.

**PURPOSE**

Subsidence is treated to minimize damages where high-valued improvements are involved or where there is high hazard to human life. It is also treated to reduce pollution of surface and ground water, prevent soil degradation, improve landscape resource quality, and restore or maintain a beneficial use.

**CONDITIONS WHERE PRACTICE APPLIES**

This standard applies to locations where surface subsidence from the collapse of underground mining is threatening rural buildings and structures, roads, dams, and ponds; decreasing land values; interfering with surface drainage or water supplies; creating a hazard to human life; damaging landscape values; and creating a nuisance or preventing beneficial use.

**CRITERIA**

**Controlled backfilling.** Controlled backfilling methods can be used where the mine is accessible and can be traversed to key areas for the filling operation. Bulkheads are built in mine passage around the periphery of the work area for containment of the fill. Drains may be incorporated in the bulkheads to facilitate rapid water removal. Bulkheads are built of wood or other suitable material. Vertical injection boreholes should be minimum of 30 cm (12 in) in diameter. At the base of each hole, a 90° long radius pipe elbow is placed whereby the slurry can be diverted to horizontal pipes and

distributed into the mine workings. Boreholes through bulkheads may also be utilized.

**Blind backfilling-gravity method.** If abandoned mine openings are inaccessible because of flooding or caving, blind backfilling must be used. Pipes are installed from the surface into the mine openings through drill holes and granular material is flushed in with water under the force of gravity. In the gravity feed method, the injected granular material builds a cone under the injection pipe. When the cone builds up to the mine roof, no more fill will enter the mine and a new hole must be drilled.

**Blind flushing pumped-slurry injection.** In the pumped-slurry method, durable granular material is blended with water, and the suspension (slurry) is pumped to the point of injection. Energy provided by the pump and the static head in the bore hole give the velocity required to keep the solid particles in suspension and to transport them. As the slurry firsts enters the open space, its velocity drops rapidly, and the solid particles settle out in a mound. As the mound approaches the mine roof, the velocity of the slurry increases through the narrowing channels, and the solid particles are transported to the outer limits of the mound. Here the velocity again decreases abruptly, the solids are deposited, and the mound is built outwards until resistance to flow reduces the velocity below that required to transport the solids. This may be several hundred feet, depending on particle size and concentration and other factors. Exploratory drill holes may be needed to determine the extent and effectiveness of backfilling.

**Daylighting.** Stripping, replacement of the overburden and complete reclamation are the most effective methods of subsidence

treatments. The hazard to personnel and equipment caused by the subsurface voids is a major consideration in planning equipment movement and mining operations; therefore, the plan must include procedures to establish firm support. It may be necessary to excavate and backfill the anticipated travel paths ahead of the complete stripping operation. If the remaining coal is not to be removed, care must be taken to open all rooms and travelways and ascertain that they are completely backfilled with overburden material before initiating other backfill operations.

**Surface treatment.** Surface filling of subsidence areas is usually applicable when drainage cannot be obtained or other important factors make filling a practical alternative. Some areas of subsidence may be considered low hazard and sufficiently stable to permit land use operations after surface filling. Drainage systems can be used to eliminate excess water. Diversions can be used to keep runoff water from entering the treatment areas, and land smoothing and grading can be used to ensure positive drainage. Pumped drainage may be necessary if a gravity outlet is not available.

**Borrow areas.** Any areas used for borrow for backfill operations should be reestablished to their proper uses in accordance with appropriate NRCS standards.

**Environmental.** All disturbed areas shall be reshaped and regraded to blend with surrounding land features. Visual resources must be given the same consideration as other design features in planning, design, and installation. Exposed areas of earth shall be covered with soil materials and established with vegetation or protected by other means as soon as practicable. Access roads must be maintained and foot and vehicular traffic controlled to protect the work.

## CONSIDERATIONS

1. Geologic environment of the immediate area, including characteristics of overburden such as lithology, faults, joints, and attitude.
2. Surface and subsurface hydrologic conditions.
3. Mining history.

4. Postmining history and conditions.
5. Land use.
6. Vertical and horizontal dimension of voids.
7. Depth of voids below land surface.
8. Size, type, and distribution of pillars.
9. Surface topography and drainage pattern.
10. Availability and quality of backfill material.
11. Availability of slurry water.

## General

If high-valued improvements or danger to human life are involved, the hazard can be reduced by backfilling the mined-out areas under and adjacent to the improvements with hydraulic or blind backfilling. If the mined-out voids are not too deep, a stripping operation can be used to eliminate present and further subsidence problems. Surface treatment may be used to reduce the harmful effects, recognizing that future subsidence may occur and additional treatment will be necessary.

## Water Quantity

1. Effects on the water budget, especially on volumes and rates of runoff and ground water recharge.

## Water Quality

1. Effects on erosion and the movement of sediment and soluble and sediment-attached substances carried by runoff to surface and ground water.
2. Effects on the movement of dissolved substances to ground water.
3. Potential for uncovering or redistributing toxic materials that might cause undesirable effects on water or plants.
4. Short-term, construction, and maintenance effects on the quality of water resources.
5. Effects on wetlands or water-related wildlife habitats.
6. Effects on the visual quality of water resources.

#### **PLANS AND SPECIFICATIONS**

Plans and specifications for subsidence treatment shall be in keeping with this standard and shall describe the requirements for applying the practice to achieve its intended purpose.

#### **OPERATION AND MAINTENANCE**

Sites must be monitored to determine the effectiveness of the backfilling. Surface treatment may be required to reduce the harmful effects of subsidence.